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WANL-TME-1645

July 27, 1967

Westinghouse Astronuclear Laboratory

NOTES OF MONTHLY DEVELOPMENT TEST PROGRAM REVIEW MEETING
HELD WITH SNPO AT WANL ON JULY 19, 1967
(Title Unclassified)

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(Title Unclassified)

Westinghouse Electric Corporation
Astronuclear Laboratory
P. O. Box 10864
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Classification cancelled (or changed to)
by authority of H. F. C. TIC, date SEP 18 1973
by _____

E. A. DeZubay, Manager
Thermo-Flow Laboratory

INFORMATION CATEGORY

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7/28/67
Authorized Classifier Date

C. L. Meuche, Manager
Engineering Mechanics Laboratory

~~GROUP 1 - Excluded From Automatic
Downgrading and Declassification.~~

Approved:

F. D. Retallick, Deputy Manager
Reactor Engineering

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SPECIAL REVIEW FINAL DETERMINATION	REVIEWERS	Class.	Date
	KAW	U	4-11-82
Class: <u>U</u>			

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NOTES OF MONTHLY DEVELOPMENT TEST PROGRAM REVIEW
MEETING HELD WITH SNPO ON JULY 19, 1967

Attendees:

R. Eichbauer	WANL	H. Murphy	SNPO-C
N. Ettenson	WANL	J. Olinger	WANL
H. Fix	WANL	M. Rieb	AGC
W. Havener	WANL	W. Rowan	WANL
G. Kalvin	SNPO-C	N. Spofford	WANL
I. Kanter	WANL	D. Thompson	WANL
H. Morgan	WANL	E. Watjen	WANL
R. Muth	WANL		

The Monthly Development Test Program Review Meeting was held on July 19, 1967.

Lists of the tests performed and planned next period by the Thermo-Flow and Engineering Mechanics Laboratories were distributed to those in attendance. These schedules are shown in Tables I and II.

The individual tests were then discussed in the order shown.

TABLE 1
THERMO-FLOW LABORATORY TEST SCHEDULE

PERFORMED THIS PERIOD

PLANNED NEXT PERIOD

Tests for NRX-A6

TFL-1. a Single Cluster Tests

Test	Configuration	Min.
14c	Irregular Tungsten Cup, Modified Skirtless Block (Adjacent to LASL Cluster)	
16a	Composite Cup and Modified Support Block (Adjacent to LASL Cluster)	
16b	Same as 16a	29.4
16c	Same as 16b	30.7
	Metallographic Examination Complete.	60.1

Metallographic examination complete.

No further cup tests.

LASL cluster with foil washers for stress relief - 60 minute endurance test.

Exit gas thermocouple - two short cycles (5 minutes) at 4450°R and 4600°R

TFL-2. a Filler Strip Model

Preliminary analysis of TFL-2. a. 0002, Cycle 1.
Cycle 2 conducted for 17.0 minutes at power with hydrogen.

Model disassembled and visually inspected.
Preliminary analysis of Cycle 2.
TFL-2. a. 0003 defined.

TFL-2. a. 0003 design and procurement.

Filler Strip Orifice Test
Conducted Leakage Tests

No activity.

TABLE 1 (CONTINUED)

PERFORMED THIS PERIOD	PLANNED NEXT PERIOD
<p>General Development</p> <p>TFL-1.b Single Element Tests</p> <p>Total Tests - Thirty-Three (33)</p> <p>Ten (10) tests, Phase I-E, A-6 elements at A-7 Screening Test Conditions.</p> <p>Eight (8) tests, Phase I-4B, A-4, A-5, and A-6 Elements at A-6 Test Conditions.</p> <p>Eight (8) tests at High Power Levels, HV Elements (3) for furnace development, (3) from Phase I-B, and (2) from Phase II-FA.</p> <p>Three (3) tests for Hot End Chuck Development and (4) tests for Furnace System Check-Out.</p> <p>TFL-5.b Interstitial Corrosion Tests</p> <p>Conducted wide slot pyrofoil corrosion tests.</p>	
	<p>Tests of high void Phase I-B elements, Y-12 matrix coated at WEF at 1280 KW.</p> <p>Additional tests of Phase II-FA elements, high void impregnated and non-impregnated. Phoebus IB elements as per Phase I-3B.</p> <p>Tests of other high void elements at high power levels. Tests for chuck development.</p> <p>Continue testing.</p>
<p>Facilities</p> <p>Safety Review of 5000 Gallon Dewar.</p> <p>Tentative Location on 20,000 Gallon Dewar.</p>	

TABLE 2
ENGINEERING MECHANICS TESTING

Performed This Period (July 1967)

Planned Next Period (July 1967)

Tests for NRX A6			
EML-C.1	Cup Proof Tests LASL Pedestals Tungsten Cups Carbide Cups (H Section)		
EML-C.3	Tie Rods		
EML-D.1	Lateral Support Spring Relaxation Tests	EML-D.1	Lateral Support Spring Relaxation Test Complete
EML-D.5	Dynamic Test of Partial Core		
EML-E.2	Friction Tests		
EML-E.4	Filler Strip Keyway Test	EML-E.4	Complete Proof Tests
		EML-	Anti-Criticality Poison System Transportation Test of NRX-A6 Poison Rods
Tests for NR-1			
EML-A.4	Ganged Drum Drive Band-Tensile Tests	EML-A.4	Fatigue Tests on Bands
EML-C.1	Development of Design Criteria for Creep of Carbide Composites	EML-C.1	Continue Testing Begin Pedestal Development Tests
		EML-E.4	Pyrofoil Compaction Tests
General Development			
EML-A.2	Beryllium Reflector Properties (NRX-A6)	EML-A.2	Beryllium Reflector Properties
Facilities			
EML-C.1	Thermal Shock Tests for Aft End Cluster Supports		Checkout New Friction Furnace Temperature Only
EML-H.1	XECF Resonant Survey		

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TESTS FOR NRX-A6

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TFL-1.a Single Cluster Development Tests

(C-RD) The irregular tungsten cup and modified regular NRX-A6 support block that had been tested in TFL-1.a. 0014A, B, and C, for a period of 60 minutes, were sectioned and metallographically examined by the Materials Department. The support block was severely corroded because of coating losses on the leading face in cycle 14A. The cup was carbided through approximately 30% of its wall thickness, and there were also some cracks in the carbided layer. This carbiding took place on the inside surface of the large cup only. Figure 1 shows the hardness profile versus the radial dimensions of the tungsten cup after the test. It is planned to section a cup from the same batch, without testing, to determine the condition of the cup prior to the test. Tests TFL-1.a. 0016A, B, and C, were conducted using a composite cup and modified support block. The first cycle was aborted prior to attaining full power because of excessive tie rod temperature. The second cycle achieved approximately 29.4 minutes at full power and rated temperature. The third cycle was conducted for approximately 30.7 minutes at full power and rated temperature. The post test metallographic examination showed the composite cup to be in excellent condition with no voids or cracks. Figures 2 and 3 show the condition of the composite cup after the test. No further tests on the composite cup are anticipated. It is planned to conduct a 60 minute endurance test on a LASL cluster with foil washers for stress relief. It is also planned to conduct a test on an A6 exit gas thermocouple. The test is to be conducted in two five minute cycles at 4450°R and 4600°R.

TFL-2.a Filler Strip Corrosion Test

(C-RD) A preliminary analysis of TFL-2.a. 0002 Cycle 1 was completed. Temperature and pressure data reduction is in progress. The assembly was not damaged beyond repair. There was a corrosion path on the inside of the simulated cluster which was repaired with C-14 graphite cement. The test was conducted

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HARDNESS PROFILE VERSUS RADIAL DIMENSION OF
TUNGSTEN CUP AFTER TEST TFL-1.a.0014C

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FIGURE 2

SUPPORT COMPONENTS AFTER 60 MINUTES OF TEST TIME
AT 4300 R - SHOWING LEADING FACES

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FIGURE 3

SUPPORT COMPONENTS AFTER 60 MINUTES OF TEST TIME
AT 4300°R - SHOWING TRAILING FACES

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(C-RD)

for another cycle and operated for a period of 17 minutes with hydrogen. The test was terminated because of heater failure. An attempt was made to reach a temperature of 3700°R in the filler strip area but because of the physical limitations of the heater, this temperature could not be attained. The model was disassembled and visually inspected and the element and filler strips were found to be corroded. Substantial corrosion was found on several of the filler strips. There were two axial cracks propagating from the hot end of the simulated cluster, both of which were corroded completely through the cluster. The design of the model for test TFL-2. a. 0003 has been defined. The assembly will be quite similar to the TFL-2. a. 0002 test model. The major differences will be a coated inner core, thicker pyrotile, modified hot buffer filler strips and the filler strips will not be coated. The heater design has not definitely been decided upon. If time permits a new heater will be used; otherwise, the same type heater as was used in TFL-2. a. 0002 will be used in the new model. Procurement of the hardware is on schedule and the test will be conducted as soon as it is received.

Filler Strip Orifice Test

(U)

Blank orifice leak tests were performed on two one inch segments of the forward end of two filler strips. The tests were conducted at 50 psig with helium gas at ambient temperature. The tests measured leak rates around the silastic seal of the blank orifice and also the leak rate due to permeability of the graphite. The total leak rate for these tests was well within the acceptable limit of 450 scc/min at the above test conditions. There is no further activity planned in this area.

EML-C.1 LASL Pedestals

(C-RD)

In order to combat the tendency of the LASL protection cups to develop a circumferential crack at low loadings in the crack initiation test, the effect of pyrofoil washers was investigated. One pyrofoil washer did not provide any increase in capacity; but with two such washers, it was possible to get to 1300 lbs before the crack was initiated. A second sample with two pyrofoils developed a very fine crack (40 x magnification) at 900 lbs loading which could be positively identified after 1100 lbs loading. Without the pyrofoils the cracking was wide enough at 900 lbs to be easily identified. It is believed that while there is a possibility of a crack occurring in a composite protection cup in the reactor, the use of pyrofoil washers will reduce this possibility markedly and at the same time tend to seal off any actual coating break from contact with the gas. In addition the 900 lb loading is quite conservative and may never be reached during operations.

(C-RD)

An additional test was run on a pedestal assembly by assuming all the load on the center elements. This compacted the pyrofoils between the center element and pedestal but there was no tendency for the foils to expand radially and exert hydraulic pressure on the confining edges of the protection cup. The six LASL pedestal assemblies, provided for these tests, have been used for multiple tests during the NRX-A6 proof test phase. Therefore no untested specimens are available for further development testing of this design.

Tungsten Cups

(U) A single set of cups was given a one hour creep test at 1100 lbs and 4300°R. No damage or distortion was produced. Two sets of cups was given a crack initiation test at 1500 lbs and 4300°R which, also, produced no cracking or distortion and confirmed previous findings in similar tests. Design criteria for these tests was 1200 lbs without initiation of a crack. A room temperature loading test was conducted on still another set of cups which failed at 4000 lbs. This compared closely with two previous room temperature tests.

(U) A double set of irregular tungsten cups were loaded simultaneously with 2200 lbs for one hour at 4300°R. No damage or distortion was noted in either set of cups. These cups were reacted against an irregular two hole support block to simulate the actual configuration used on the NRX-A6 periphery.

(U) The above proof tests have demonstrated that the tungsten cups will not crack or distort under normal reactor loadings and temperatures. No hot tests have been carried to failure to date because of tight furnace schedules.

Carbide Cups (H Section)

(C-RD) A total of 17 tests were run on 7 carbide composition cups of which three specimens were Carborundum Company material and the remainder LASL. One of the Carborundum Company specimens was creep tested for one hour at 1100 lbs load and 1100°R temperature. No distortion or damage was discovered. A second Carborundum Company sample was tested at room temperature and failed at 2500 lbs. A third sample was given crack initiation test series and developed a circumferential

crack at 1700 lbs loading and 4300°R. Design criteria for this test specified a load of 1200 lbs without cracking.

(C-RD) The LASL samples were also tested on crack initiation tests well above the 1200 lb design point. Two were carried through to failure at 1900 lbs and 4300°R and two others are presently awaiting furnace availability for the conclusion of the test series.

(C-RD) All carbide cups tested used a large and a small pyrofoil washer between the support washer and the cup ledge and a large pyrofoil washer between the insulating cup and the cup ledge. All auxiliary hardware was reactor grade.

EML-C.3 Tie Rods

(U) Static tension tests were performed on 20 tie rods taken from Lot HC-1 and 20 tie rods from Lot HC-2. The purpose of the tests were to determine the lot acceptability for quality control on the basis of yield stress, ultimate stress, and percent elongation. The results of the tests indicate that approximately 50 percent of the samples failed at least one of the requirements defined on the drawings. It was necessary for Design personnel to evaluate the data. The conclusions of the Engineering Review Board (ERB) were that the strength and elongations are adequate, and therefore, are acceptable for assembly into the NRX-A6 reactor.

(U) Each tie rod was placed in the tensile test machine and pulled until failure occurred. The load and deflections were recorded. Evaluation of this data, summarized in Table 1 was used to determine 0.2% yield stress, ultimate tensile stress, and percent elongation. In all 40 cases failure occurred as required in the shank of the tie rod.

TABLE 1

.2% Yield Stress Required Minimum 150,000 psi			Ultimate Tensile Test Required Minimum 180,000 psi		Percent Elongation Required Minimum 5%	
Lot	Average 20 Samples	Min.	Average 20 Samples	Min.	Average 20 Samples	Min.
HC-1	160,500	143,600	195,650	181,300	8.3	6.0
HC-2	145,900	141,000	182,500	176,000	5.9	4.3

After completing the tests the samples were returned to Q.C. for the ERB evaluation which accepted the lot as previously discussed.

EML-D.1 Lateral Support Spring Relaxation Test - (NRX-A6)

(U) A temperature-load test on one NRX-A6 reactor grade lateral support spring (P/N 979D482) was conducted to determine set versus temperature. This spring is used in the reactor in the first 3 rows of the lateral support system. The test is similar to the spring tests that were previously performed and reported in WANL-TMI-1777.

(U) The spring was assembled in a test fixture and was compressed to the operating length of 3.300 inch that the spring experiences in the reactor. The spring was then heated to 700°R and held at this temperature for one hour. After the test the free length of the spring was measured and the load to compress the spring to a length of 3.300 inches was determined. These measurements were compared to those taken before the test. The test was repeated on the same spring for temperatures of 950, 1100, 1250 and 1400°R with measurements taken before and after each test.

(U) No measurable set or significant load change occurred after the first four tests, and only a 0.020 inch set occurred at the 1400°R

temperature test. These test results indicate a satisfactory spring design at the maximum spring temperature anticipated in the NRX-A6 reactor.

EML-D.5 Dynamic Test of Partial Core (EML-86)

(U) An NRX-A6 displacement transducer, used on the partial length core, was vibrated in the frequency range of 7 to 500 cps. The transducer is basically a cantilever beam with a strain gage mounted at the root section. In the reactor, core motions will cause the beam to displace. The resulting output signal from the strain gage is monitored on a tape console, meters and oscillographs.

(U) The purpose of the laboratory sweep and dwell tests were to determine if an erroneous signal could be generated. The transducer, plunger pin and fixture are shown in Figure 4. The plunger pin was locked in a position to simulate the reactor condition where there is no relative motion between the core and reflector. The assembly was bolted to the slide plate of the oil film slip tables (Figure 5). Motions parallel to the center line of the plunger pin were controlled from the output signal of an accelerometer. The tests were performed at various fixed displacements and g levels.

(U) The transducer exhibited output signals at frequencies which were dependent upon plunger position and driving g levels. The results are summarized in Figures 6 and 7. Since the false signal occurs at frequencies above 350 cps, proper filtering will be inserted into the field monitoring equipment.

FIGURE 4
NRX-A6 DISPLACEMENT TRANSDUCER
AND TEST FIXTURE
EML-D.5

FIGURE 5
TEST ARRANGEMENT FOR VIBRATION TEST
OF NRX-A6 TYPE DISPLACEMENT TRANSDUCER
EML-D.5

FIGURE 6

Variations in Natural Frequency Relative to Position
 Of Displacement Transducer
 EML-D.5

FIGURE 7

Apparent Amplitude of Displacement Transducer Set At
 NRX-A6 Reactor Position
 EML-D.5

EML-E.2 Friction Tests of Reactor Components

(C-RD) Tests of pyrofoil, as a sliding interface between uncoated filler strip and NbC coated fueled element specimens, were performed in hydrogen at 4150°R temperature and 40 psi contact pressure to determine the coefficient of friction that would occur during the test operation of NRX-A6 reactor.

(U) The tests were conducted by simultaneously heating and sliding of the test specimens followed alternately by temperature and motion "holds". The temperature and motion profile in Figure 8 is a simulation of average filler strip temperatures and motions anticipated to occur during reactor test operation. The temperature and motion profiles in Figures 9 and 10 are for higher initial temperatures and are to provide coefficients of friction for filler strip temperatures that exceed average values.

(U) Two four cycle tests of each profile were performed. The maximum measured coefficient of friction for Figure 8 was 0.19, for Figure 9 was 0.21, and for Figure 10 was 0.28. These values occurred after the 3750°R hold for Figures 8 and 9 and after the 3500°R hold for Figure 10. A coefficient of friction of 0.21 or less was considered acceptable for the NRX A6 design. The higher coefficient of friction of 0.28 has limited acceptability provided that these friction values do not exist over the entire length of the filler strip.

EML-E.4 Filler Strip Keyway Test

(U) The program to test the filler strip keyways is complete. The results confirm the A6 analysis which shows the filler strip keyways unreliable for backup support. The interlocking design was originally intended to serve as a redundant axial support scheme for the A6 filler strips should the primary method of friction support prove insufficient.

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Friction Test
 Time-Temperature-Motion Profiles
 EML-E.2

(U) Figure 11 depicts schematically the interlocking design. The most severe loading condition to the filler strips would occur during reactor startup when the key loads the upper ledge of the keyway. Ultimate strength tests of the filler strips in core positions 10, 11, 18, 19 and 27 were performed as these represent the thinnest and thickest filler strips.

(U) A schematic of the test rig and photographs of the laboratory test arrangement are shown in Figures 12, 13, and 14. The lateral load spring of 234 lb/in stiffness is used to apply a load of 15.7 lbs to the back of a filler strip opposite the upper ledge of the keyway. This load condition simulates the action of lateral compression springs on a single filler strip through the first row of seal segments in the reactor.

(U) Test results are presented in Table 2. In all cases the failure occurred as a fracture across the keyway cross section at the upper ledge. These test results verify A5 keyway failures. These data, and the A6 analysis, resulted in the element keys being cut back and filler strips positioned forward to prevent these high failure loads from occurring.

Figure 11 Interlocking Key - Keyway Design At the A-6 Core Periphery
 EML-E 4

Figure 12. Schematic of Filler Strip Keyway Test Setup
 EML-E 4

FIGURE 13
KEYWAY STRENGTH TEST SETUP
EML-E.4

FIGURE 14
KEYWAY STRENGTH TEST FIXTURE
AND FRACTURED SPECIMEN
EML-E.4

Table II Filler Strip Keyway Ultimate Strength Test Results

Filler Strip Core Position	Test Sample	Failure Load (lbs)	Average Failure Loads (lbs)
10	1	109	120
	2	119	
	3	133	
11	1	94	106
	2	119	
	3	106	
18	1	230	202*
	2*	205*	
	3*	199*	
19	1	215	219
	2	227	
	3	214	
27	1	110	105
	2	111	
	3	95	

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NR-1

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EML-A.4 Ganged Drive System

Tension tests on a candidate material for use on the ganged drive band system have been performed to obtain physical properties at cryogenic temperature that can be correlated with future low cycle fatigue tests.

Specimens were made of titanium alloy (5% Al, 2-1/2% Sn) per PDS 30067-1.

- (U) The gage length of the specimen was 4.00 inches with a cross section dimension of 0.750 by .0115 inches. A total of eleven specimens was tested to failure. Nine specimens were tested at liquid nitrogen temperature (140°R) and two specimens were tested at ambient temperature. The average values obtained from the test are shown below.

<u>Temperature</u>	<u>Youngs Modulus, psi</u>	<u>2% Yield Strength, psi</u>
140°R	18.3×10^6	187,000
Ambient	16.5×10^6	106,000

- (U) A photograph of a typical failed specimen is shown in Figure 15.

EML-C.1 Development of Creep Criteria for Carbide Composites

A program is being conducted to develop design data for creep criteria of carbide composite specimens that simulates the interface of the reactor cluster element end and aft end support pedestal. This test data will be used to provide design criteria for high contact stresses caused by unequal cluster element lengths and provide design data for carbide composite materials at high temperatures and stresses.

- (C-RD) In a cluster, element length variations of 7 mils can occur due to non-uniform heating, unequal friction coefficients and tolerance build ups. Assuming one of the elements, (i.e. the central element) was required to bear the full tie rod load the pedestal would have to creep

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FIGURE 15
A TYPICAL TITANIUM BAND
TENSILE SPECIMEN AFTER FAILURE
EML-A.4

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without failure for 7 mils at stresses of approximately 7500 psi until the remaining cluster elements seated on the pedestal. Three materials, LASL NbC and Carborundum TaC and NbC were tested to evaluate this condition.

(C-RD) The three specimens of each material were tested at various stresses and a constant temperature. These specimens consisted of stacks of NbC coated carbide composite discs and washers of various geometries to simulate the element end-aft end support interface.

(U) The tests, conducted in the high pressure bundling furnace, consist of heating the specimen stack to a predetermined temperature then applying the load at a 12 pound/sec rate. The creep rate is indicated by a dial gauge which monitors the lower load plunger travel.

(U) The Carborundum TaC composite stacks were tested at 5260^oR, a target temperature, and maximum initial stresses of 7100 psi, 4700 psi and 4130 psi for one hour. All failed emphatically. Total deformation was .650" .320" and .249", respectively, as severe cracking and coating spalling occurred. The results show the test temperature was excessive for this material and that further tests should be conducted at lower temperature.

(C-RD) The LASL NbC composite stacks were tested at 4810^oR and maximum initial stresses of 4500 psi, 4500 reduced to 1900 psi after 7 mils creep and 1900 psi for one hour. The second specimen test conditions simulate reactor conditions, as after 7 mils creep of the pedestal, the remaining elements come to bear, reducing the stress to 1900 psi. All of these specimens exhibited excellent creep characteristics with permanent sets of 27 mils, 8 mils and 8 mils, respectively. No bulging, cracking or coating spaling was observed.

(C RD) The third set of specimens presently being tested are Carborundum Co. NbC composite. Two samples have been tested at 4810^oR and at maximum initial stresses of 7950 and 4550 psi for one hour. The third specimen to be tested at 4550 psi is being corrosion tested prior to the creep tests. The first specimen had a permanent set of 78 mils with maximum bulging of 35 mils. The second

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specimen had a permanent set of 50 mils and maximum bulging of 28 mils. No cracking or coating spalling was observed; however, post-test inspection is not complete.

(U) These preliminary tests have shown that NbC composite material will not crack, creep excessively or experience coating spalling at 4800°R when subjected to nominal stresses (4500 psi) which could occur due to unequal fuel element length.

(U) However, the results also show the variation between samples supplied by manufacturers and a need for creep testing over a range of temperatures for these materials to determine their maximum temperature and stress capabilities.

(U) Additional billets are required for more complete creep testing from 4300 to 5000°R and stresses of 2000 psi to 8000 psi to develop reliable design data on the carbide composite materials.

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TFL-1. b Single Element Process Development and Evaluation Tests

(C-RD) There were 33 single element experiments conducted during the period. Of the 33 tests, 10 were part of I-E; A6 fuel elements tested at A7 screening test conditions. The A7 screening conditions are 1120 KW at 742 scfm and 1280 KW at 850 scfm. One element completed a 60 minute test at 1280 KW power. Eight of the tests were conducted at high power levels with high void elements; three for furnace development, three as part of Phase IB, and two as part of Phase II-FA. Eight other tests were conducted as part of Phase I-4B, A4, A5, and A6 elements at A6 test conditions. There were four other tests conducted for furnace system checkout and three tests for hot end chuck development.

(C-RD) The single element furnace system has been modified with the installation of a heavier hydrogen pressure reducing valve. A complete flow and pressure system calibration and maintenance program has also been completed. It is planned to conduct tests of high void Phase I-B elements, Y-12 matrix coated at WEFF at 1280 KW. Additional tests of Phase II-FA elements, high void impregnated and non-impregnated elements, Phoebus 1B elements as per Phase I-3B, tests of other high void elements at high power levels, and tests for chuck development.

TFL-5. b Interstitial Corrosion Tests

(C-RD) Two tests studying the effects of reaction area change on the corrosion rate of "Grafoil" were conducted at the following conditions with the following results:

Specification No.	36-37-1	39
Test Number (TFL-5. b.)	043	044
Test Time (min.)	30	15
Inlet Pressure (psig)	350	350
Inlet Gas Temperature (°R)	545	550
Average Material Temperature (°R)	3494	3502
Flow Rate (lb/sec-H ₂)	8.58×10^{-5}	8.62×10^{-5}

Graphite Weight Loss (gsm)	0.014	0.059
Initial "Grafoil" Weight (gms)	0.327	0.333
"Grafoil" Weight Loss (gms)	0.311	0.133

(C-RD) The specimen consisted of the standard pyrofoil window opposite a 0.840 inch wide, 2 inch long, 0.006 inch thick flow slot. The main objective of the fixture being to increase the area of the "Grafoil" exposed to the hydrogen flow. Figure 16 is a layout of the specimen showing the coated Graphitite "G" halves, grafoil coupon, split inlet plugs, and the beveled retaining ring.

(C-RD) During this test, the pressure differential across the test specimen was high in comparison to the normal slot tests by a factor of 2.5. This indicated that the "Grafoil" had buckled and partially blocked the flow slot. Corrosion of the "Grafoil" coupon considerably reduced its original size. The remaining material was approximately 1.5 inches in length, 0.3 inches in width and had pin holes through the existing surfaces. Figures 17 and 18 show a before and after test comparison of the coupon. Note that the after test photo shows the foil fixed to the opposite specimen half.

(C-RD) The second test specimen had the same configuration but was tested for only 15 minutes. The high pressure differential noticed during the first test was not present in the second test. The corrosion damage on this coupon was not as severe due to the time difference and the limited amount of buckling. Examination of the coupon showed that there was flow along the back side which indicates that some deformation did take place. Figures 19 and 20 show the fixture before and after test. Figure 21 shows the reverse side of the coupon.

(U) Work is in progress to eliminate coupon deformation which influences corrosion rates by exposing different reaction areas to hydrogen. Coupons are being made from 0.10 inch bonded laminate. This heavier material should reduce the coupon deformation.

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FIGURE 16

"GRAFOIL" COUPON AND SUPPORT HARDWARE

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FIGURE 17
"GRAFOIL" COUPON PRIOR TO 30 MINUTE TEST

FIGURE 18
"GRAFOIL" COUPON AFTER 30 MINUTE TEST

FIGURE 19
"GRAFOIL" COUPON PRIOR TO 15 MINUTE TEST

FIGURE 20
"GRAFOIL" COUPON AFTER 15 MINUTE TEST

FIGURE 21

REVERSE SIDE OF "GRAFOIL" COUPON AFTER 15 MINUTE TEST

EML-A.2 Beryllium Properties

(U) Two low cycle fatigue tests at 140 R were completed on 0.75 inch diameter specimens machined from the NRX-A6 ring pressing no. 4055. One specimen failed at 15 cycles and the other at 43 cycles. The total strain range on both specimens was ± 1700 microinches. The plastic strain range was approximately ± 600 and ± 630 microinches for the specimens that failed after 15 and 43 cycles, respectively.

(U) The two points determined from the tests of the A6 ring pressing specimens are plotted on the curves of Figures 22 and 23 and show that the low cycle fatigue limit equals or exceeds the range of the data previously obtained from other pressings.

(U) Another specimen from pressing no. 4055 will be tested during the next period.

FIGURE 22

FIGURE 23

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(U) A safety review was made on the installation of the 5000 gallon dewar for WANL and no definite decision has as yet, been made.

(U) Based on the latest WANHES site survey, the location of the pad and access road for the 20,000 gallon dewar has been determined, subject to the review of the WANL Safety Committee.

Engineering Mechanics Laboratory Facilities

EML-C.I Thermal Shock Tests for Aft End Cluster Supports

(U) Preliminary checkout tests have begun on a fixture which has produced temperature rises of greater than $150^{\circ}\text{R}/\text{sec}$ to 3200°R under no load conditions in a graphite pedestal.

(C-RD) The tests, now being conducted in the 6 x 54 inch furnace consist of blasting Helium, at various flow rates, through a 60 inch long heat exchanger at 4500°R with the test specimens mounted on the exhaust end just outside the furnace hot zone. The fixture consists of a heat exchanger (a 19 hole unfueled element inserted in a graphite tube) and a specimen holder or graphite sleeve surrounded by a water jacket. (Ref. Dwg. NT701592). The specimens to date have consisted of regular support blocks in which temperature rises of $55^{\circ}\text{R}/\text{sec}$ were accomplished and more recently graphite pieces of approximate WANL pedestal geometry.

(C-RD) The first test with a graphite pedestal was most successful in achieving an average $170^{\circ}\text{R}/\text{sec}$ temperature rise to 3200°R and an indicated radial temperature difference of 370 to 390°R which are comparable to the figures calculated for the LASL aft end cluster support pedestals.

(C-RD) The maximum temperature achieved with the graphite pedestal was 3400°R . This will be improved by increasing the heat capacity and heat transfer surface area of the present heat exchanger by incorporating a bundle of nineteen fuel elements in place of the single element. This will provide approximately 20 times the heat capacity and over 7 times the heat transfer area of the present exchanger.

(U) The primary feature of the larger heat exchanger is that it will provide constant heat at 5000°R for a sufficient period of time to produce a

minimum of $150^{\circ}\text{R}/\text{sec}$ temperature rise to 4500°R , and will provide representative radial gradients in the aft end support pedestal while under reactor load conditions. Another unique feature of this fixture is that the specimen, the loading ram, and all necessary instrumentation are designed for rapid assembly and disassembly without disturbing the bulky heat exchanger. This will allow thermal stress testing at a rate of one a day. These preliminary tests indicate that thermal stress tests can be performed in the EML to meet the requirements of the NR-1 pedestal development program.

EML-H.1 XECF Resonant Survey

(U) The XECF resonant survey is proceeding in three phases which must be completed before shipment to the site. These are the instrumentation of the existing trailer which will be tested over local roads to see if there are any possible problem areas. The second phase is the evaluation of assembly procedures and the qualification of the fixtures for driving the core. The third phase is the preparation of a test plan to coordinate the efforts of site personnel, AGC and personnel from WANL. The preceding three phases are described in the following paragraphs.

Instrument Trailer

(U) The instrumentation has been installed in the instrumentation trailer. Wiring and checkout is 50% complete. As a pre-shipping test, the trailer will be driven over a 10 mile course. Output signals from seven strain gage accelerometers, installed on the instrument racks and trailer structure, will be recorded on an oscillograph. The power supply will be a gasoline motor drive generator. The results of the test will qualify the equipment for transit to NRDS.

Suspension

- (U) A suspension system of low natural frequency has been fabricated to suspend the shaker. A schematic sketch of the arrangement is shown in Figure 24. Tests to verify the concept have been started.

Impedance Head Drive Rod

- (U) The impedance head drive rod has been fabricated. The rod has been successfully driven at levels in excess to those anticipated. Inspections of the drive rod indicates that no change had occurred.

Triax Accelerometer to be Mounted on Lower Core

- (U) A mockup of the nozzle area has demonstrated the feasibility of successfully installing and removing a triax accelerometer. An accelerometer and mounting pad were cemented to a support and an axial load of 100 lbs did not break the bonding. The removal was made with 100 in-lb of torque with no damage to the support block.

Test Plan

- (U) The document defines in chronological order, the sequence of events leading to the conducting of the vibration survey. Each operation is described and the responsible person noted.

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FIGURE 24

XECF Resonant Vibration Survey at ETS-1 NRDS
EML-H.1